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Concept Mapping in Strategy-Based Technical Instruction: Impact on Text Recall and Procedural Performance

Donald F. Dansereau, Richard H. Hall, Angela M. O'Donnell, and Lisa Skaggs

Texas Christian University

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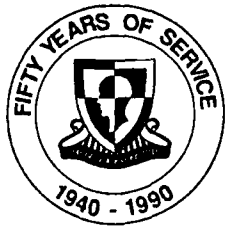

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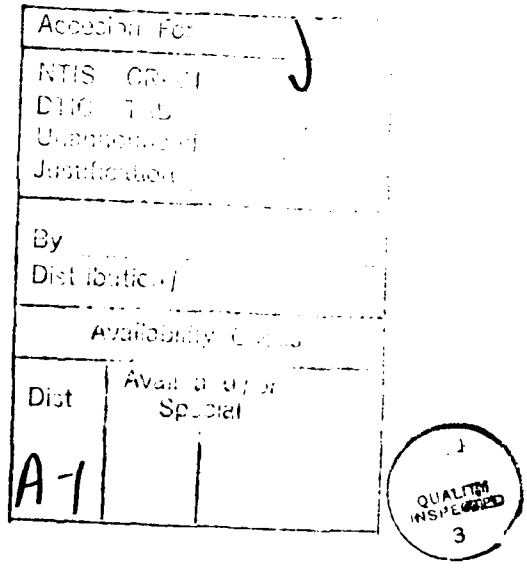

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This report summarizes tasks completed during the reporting period. The interlocking experiments covered by the section on concept mapping examine concept maps as a substitute for text. The efficacy of scripted cooperative learning as an approach to map processing is also explored. The second section explores the effect of textual disruption on individual and dyadic learning.

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CONCEPT MAPPING IN STRATEGY-BASED TECHNICAL INSTRUCTION: IMPACT ON TEXT RECALL AND PROCEDURAL PERFORMANCE

CONTENTS

CONCEPT MAPPING IN STRATEGY-BASED TECHNICAL INSTRUCTION:
IMPACT ON TEXT RECALL AND PROCEDURAL PERFORMANCE

The two interlocking experiments reported in this paper represent an examination of concept maps as substitutes for text. A second goal was to determine the efficacy of scripted cooperative learning as an approach to map processing.

Concept maps consist of two-dimensional node-link networks which interrelate important concepts (see Figure 1 for example). Mapping as a learning strategy was developed to assist learners in a manner compatible with prevailing theories of long term memory (e.g., Anderson, 1983). A variety of versions of mapping have been shown to enhance students' acquisition of information (Armbruster & Anderson, 1984; Dansereau, et al., 1979; Holley et al., 1979; Novak & Gowin, 1984). Little is known however about whether the efficacy of mapping as a learning strategy is due to the activities associated with constructing maps (e.g., reorganization of text information) or to the nature of the maps themselves.

The experiments reported here are a first step in disentangling this issue by exploring the use of maps as a substitute for text In this regard, maps as substitutes for text have a number of potential advantages. The structure of the information displayed is more accessible (Horn, 1985), complex relationships can be depicted via a series of named links, the learner can perceive how detailed information fits with central concepts, the redundancy inherent in texts is reduced, and application of knowledge is potentially facilitated because access to relevant information is expanded through the use of links between concepts (Mayer, 1979).

A preliminary pilot study was conducted, comparing map vs. text presentations of two disparate bodies of information: alcohol and circulatory/renal systems. The results of this pilot study were promising in that maps were more effective for the presentation of the circulatory/renal system material whereas the reverse was true for the alcohol information.

Two variables which may impact on map-processing are the sex of the learner/reader and students' strategy use for processing visual information. Sex differences in spatial ability have consistently been found (e.g., Linn & Petersen, 1985). In addition to possible sex differences that may impact on map-processing, Dwyer (1978) argued that students are ill-prepared to learn from visual materials. Complex visual-verbal materials such as concept maps may pose further problems.

One potential tool for improving students' ability to learn from maps is the use of scripted cooperation (e.g., Dansereau, 1985). Scripted cooperation involves two students working together to learn some material, alternating between the roles of summarizer and listener. Typically, both partners read a section of the material. One partner then summarizes the material while his or her partner listens in order to detect errors. The use of this script by students has been shown to improve student learning of both academic and technical material (Larson et al., 1986; Hall et al., in press) Scripted cooperation has also resulted in improved processing of technical visual materials (Larson et al., 1986). Furthermore, cooperation among peers has been shown to enhance comprehension of a graphic organizer (Darch et al., 1986).

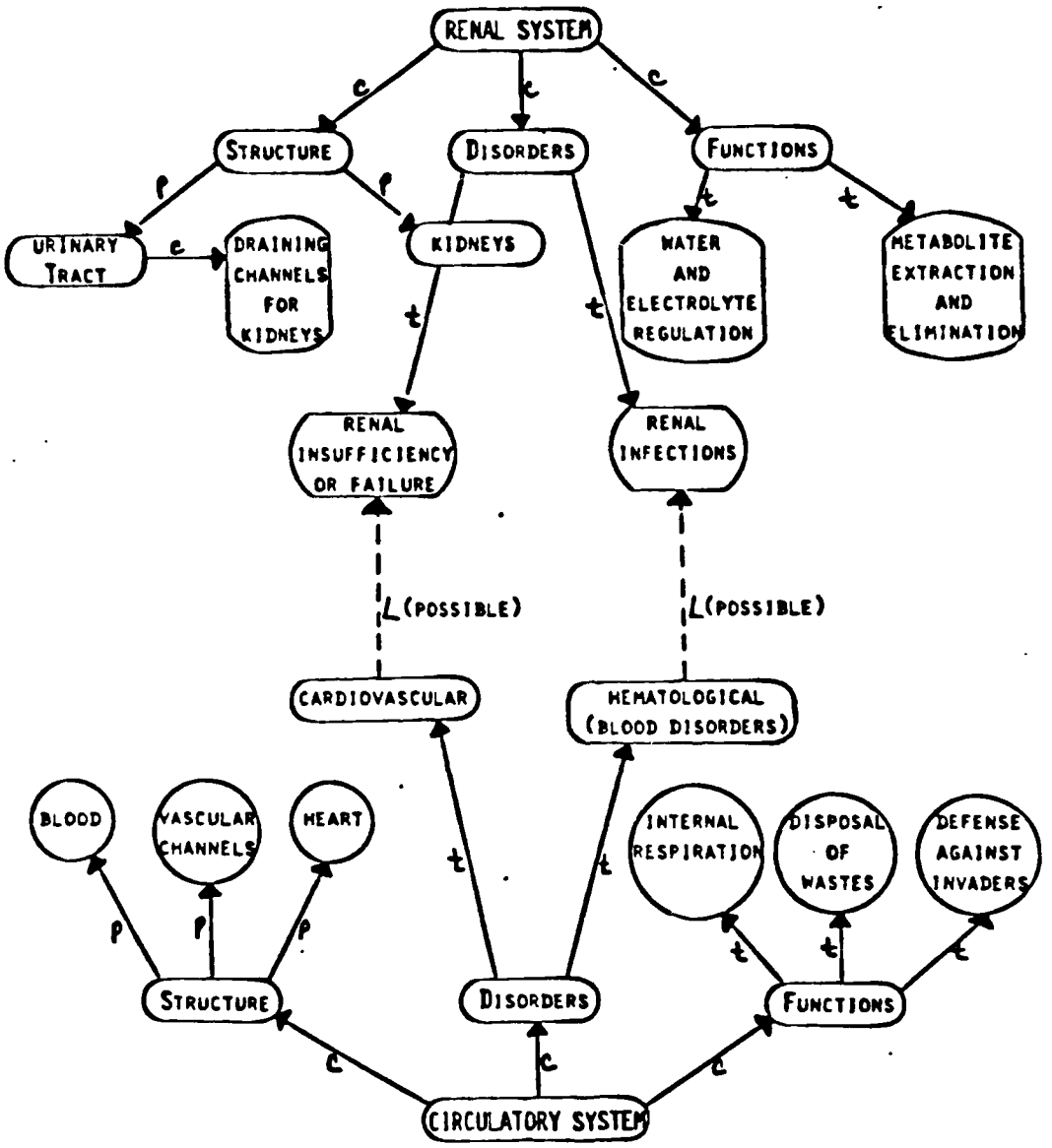

Figure 1. Example of a partial concept map.

Experiment 1

Method

Participants

Ninety-five participants recruited from psychology classes at T.C.U. completed the first experiment.

Materials

Isomorphic text and map versions of information on the circulatory/renal system and the administration of an IV were used (approximately 1000 words per text version).

Procedure

The experiment was conducted in two sessions (approx. 2 hrs each). Following brief instructions on how to read maps, participants were randomly assigned to one of four groups: (1) cooperative map group; (2) cooperative text group; (3) individual map; and (4) individual text. Map groups received map versions of the materials. Participants in cooperative groups were assigned to same-sex dyads and were directed to use a strategy previously shown to be successful (see Lambiotte et al., in press, for details). Individuals played both roles involved in the cooperative strategy. The order of presentation of the materials was counterbalanced. Participants studied each set of materials for 35 min.

During the second session, participants completed a post-study questionnaire and free-recall tests over the two sets of materials.

Results

The written recall tests were scored using procedures based on those developed by Meyer (1975). A "written recall" for each set of material was computed for each participant which reflected the total number of idea units recalled.

A 2 X 2 X 2 X 2 repeated measures ANOVA was conducted, with task as the within-subject factor. The between-subject factors were presentation order, format (map or text) and group (dyads or individuals. Dyads recalled significantly more than individuals, $F(1,87) = 5.36$, $p<.05$. Presentation order and format also interacted significantly, $F(1,87) = 5.29$, $p<.05$. Map presentations were more effective than text when the IV material was presented first while text was better for the reverse order of presentation (see Table 1).

Supplementary analyses of the impact of sex differences, using the total score from the two sets of material, resulted in a signficant Group X Sex interaction, $F(1,87) = 7.04$, $p<.01$, with females who studied in dyads outperforming male dyads and individual females (see Table 2). The Group X Sex X Format interaction was also significant, $F(1,87) = 4.03$, $p<.05$, and can be accounted for by differing patterns of outcomes for individuals and dyads (see Figures 2 and 3). Individual males using maps slightly outperformed other individuals (n.s.). Male dyads using maps however, performed very poorly whereas female dyads performed well irrespective of material format.

Analyses of the post-study questionnaire indicated that participants were more positive about map versions of the materials than the text versions.

Experiment 2: The Follow-Up

A follow-up experiment was conducted in order to determine whether the differences observed as a result of a single exposure to maps and/or dyadic learning were maintained over time and whether there were differential effects on actual performance of the IV procedure. Performance of the procedure was included in order to provide information about the locus of impact of the manipulations and consequently, the nature of maps. Further, the transition from text to a procedural enactment has been shown to be

Table 1

Experiment 1: Standardized and Raw Score Means and Standard Deviations for Total Recall of both Passages as a Function of Presentation Order and Format

Presentation Order		Presentation Format: Text		Concept Map	
IV / Systems	M	-0.05	157.26	0.20	176.92
	SD	(0.83)	(66.72)	(1.15)	(93.36)
	n	23		24	
Systems / IV	M	0.27	182.79	-0.44	124.61
	SD	(0.96)	(77.31)	(0.92)	(74.23)
	n	25		23	

Table 2

Experiment 1: Standardized and Raw Score Means and Standard Deviations for Total Recall of both Passages as a Function of Group and Sex

Group		Sex			
		Female		Male	
Individuals	M	-0.36	132.08	-0.13	150.70
	SD	(0.83)	(67.02)	(0.99)	(80.42)
	n	24		20	
Dyads	M	0.55	205.41	-0.22	143.27
	SD	(0.98)	(79.07)	(0.960	(77.70)
	n	29		22	

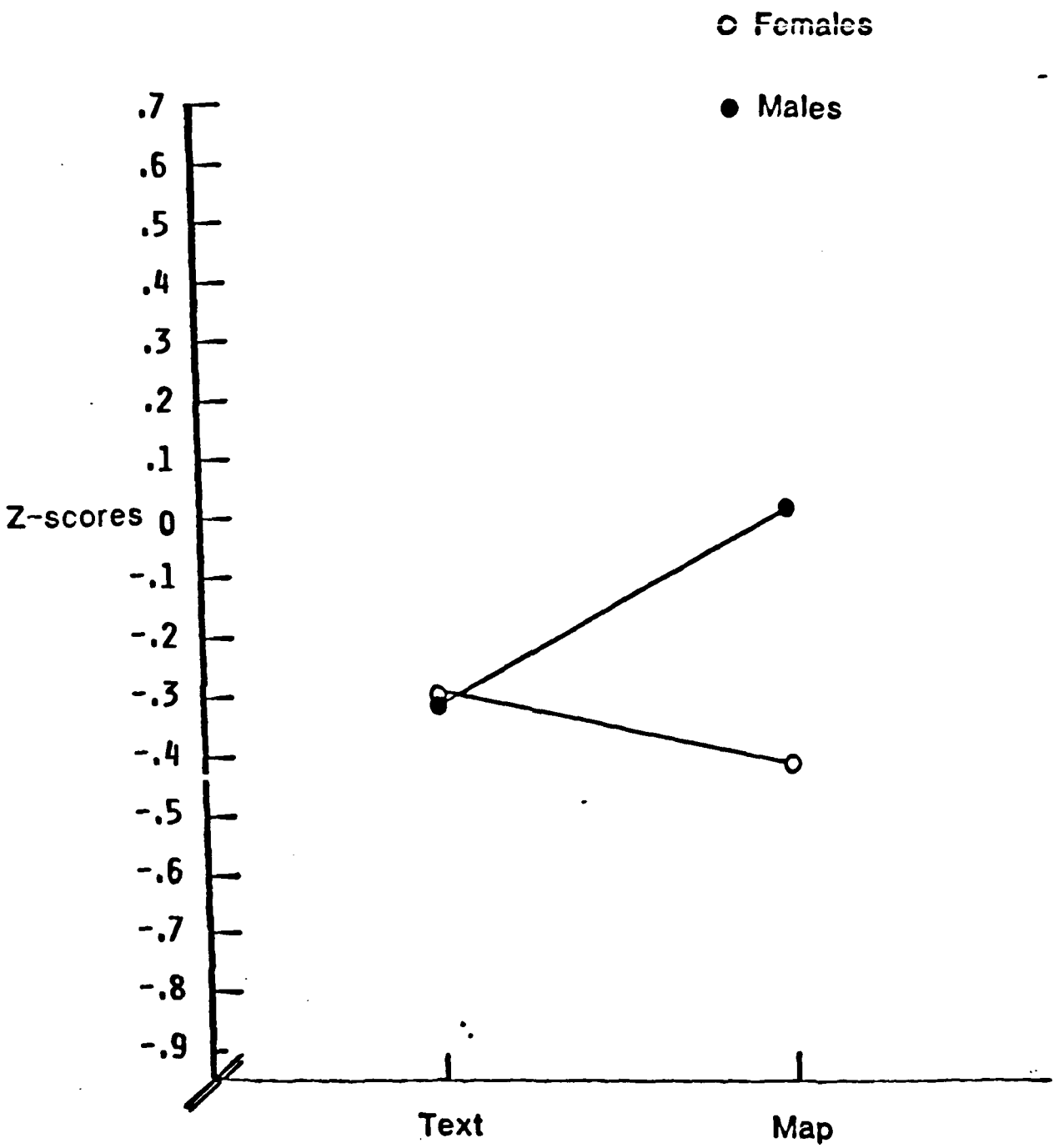

Figure 2. Experiment 1: Standardized means on combined recall from both passages for individual groups as a function of presentation format and sex.

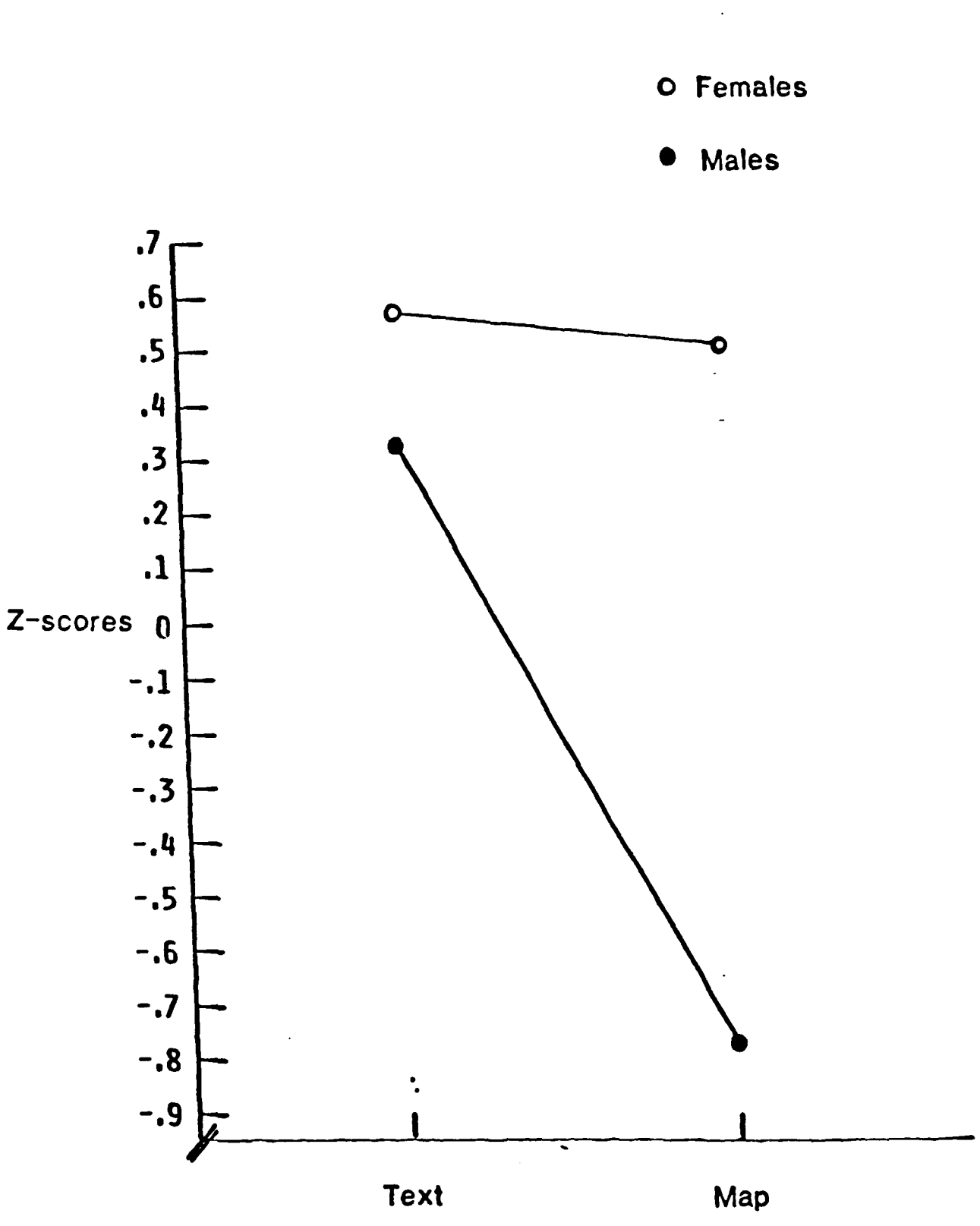

Figure 3. Experiment 1: Standardized means on combined recall from both passages for dyad groups as a function of presentation format and sex.

difficult (see O'Donnell et al., in press). It is possible that an alternative format of presentation may facilitate that transition.

Method

Procedure

Fifty-one of the original participants volunteered to participate in the follow-up, which occurred after a 3-week interval.

Procdure

Participants took free-recall tests over the two sets of materials and subsequently performed the administration of an IV, using rubber arms. These performances were videotaped.

Results

Again, dyads recalled more than individuals, $F(1,43) = 5.12$, $p<.05$. The Group X Task X Format X Order interaction was also significant, $F(1,43) = 5.21$, $p<.05$ (see Tables 3 and 4). The interaction comes from differences in the pattern of results for individuals and dyads. Order and format interacted in the dyads groups in a similar manner to that observed in the first experiment. This was not true for individuals. No significant differences were found on actual performance of the procedure as a result of the manipulations.

Again, supplementary analyses of the impact of sex differences, similar to those conducted in the first experiment, resulted in parallel results.

General Discussion

The results of these experiments replicate and extend previous research in cooperative learning by demonstrating that cooperative efforts are better than individual efforts and, further, that these effects are maintained over time.

Concept maps also appear to be effective substitutes for text under certain conditions. These conditions appear to depend on the kinds of information presented, the order in which it is presented, the sex of the learner, and the social context within which the learner encounters the material. Differences observed during the first experiment were, for the most part, maintained over a three week interval.

Concept maps appeared to most effective when the IV procedure is presented first. The IV procedure may be easier to process in map form because the time sequence and causal ordering of the steps of the procedure are readily available in the map form but not in the text version. These attributes have been shown to ease the processing demands of prose. The student may learn transferable skills from this initial exposure.

In contrast to the IV material, the circulatory/renal system material is diffuse and the map version of this material when presented may simply cause confusion and inappropriate processing.

Both males and females benefit from cooperative learning. However, while females benefit irrespective of the format of the materials, males benefit only when they study text. The fact that individually, males process maps well, suggests that the difficulty they experience in dyads may be due to failure to accommodate to the inputs of a second person. This interpretation receives some support from Perrig and Kintsch (1985) who found that females responded to differences in the format of information inputs whereas males did not.

Finally, the use of concept maps did not significantly facilitate the translation of declarative knowledge of the IV procedure into a procedural enactment, although individuals using maps performed somewhat better than those using texts. The theoretical and applied implications of these results will be presented at the conference.

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Table 3

Experiment 2: Standardized and Raw Score Means and Standard Deviations for Recall by Dyads as a Function of Presentation Order and Format

Presentation Order	Passage			
	Intravenous Infusion		Circulatory/renal Systems	
IV/Systems				
Text (n=6)	0.18	99.33	0.12	36.83
	(0.98)	(45.15)	(0.87)	(18.53)
Map (n=9)	0.56	117.11	0.69	49.11
	(1.28)	(58.94)	(1.52)	(32.46)
Systems/IV				
Text (n=6)	0.42	110.50	0.73	50.00
	(0.61)	(27.83)	(0.47)	(10.04)
Map (n=6)	-0.30	77.00	-0.59	21.50
	(0.97)	(44.52)	(0.54)	(11.54)

Table 4

Experiment 2: Standardized and Raw Score Means and Standard Deviations for Recall by Individuals as a Function of Presentation Order and Format

Presentation Order	Passage: Intravenous Infusion		Passage: Circulatory/renal Systems	
IV/Systems				
Text (n=5)	-0.80	54.00	-0.37	26.42
	(0.38)	(17.59)	(0.72)	(15.42)
Map (n=7)	-0.05	78.57	-0.48	23.80
	(0.99)	(42.86)	(0.72)	(15.29)
Systems/IV				
Text (n=5)	-0.27	88.60	-0.55	22.29
	(0.93)	(45.50)	(0.65)	(13.94)
Map (n=7)	-0.10	86.29	0.06	35.57
	(1.09)	(49.84)	(0.88)	(18.77)

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The Effect of Textual Disruption on Dyadic and Individual Learning

A great deal of research has attempted to examine the effects of textual disruption on students' comprehension (e.g., Baker, 1979). There are two salient reasons for this interest in responses to textual disruption. First, the experience of encountering unfamiliar or disrupted text readily generalizes to real world situations. Second, this paradigm is ideal for the study of comprehension monitoring skills and other text processing activities (Winograd & Johnston, 1982; Baker, 1985)

Despite an abundance of research, there are certain key aspects of the disruption paradigm which still warrant examination. First, the experiments have always been conducted within the context of individual learning despite research which has pointed to the efficacy of cooperative learning with various types of text (e.g., academic text, McDonald, Larson, Dansereau, & Spurlin, 1985, technical text, Hall et al., in press). In addition, the disruptions which have been utilized are often so subtle that students do not notice them (Markman, 1979) or have to be prompted (Baker, 1985). Lastly, only one aspect of students' reactions are normally measured (e.g. evaluation of the disruptions, Flavell, 1981; disruption regulation, Baker, 1985).

The major objective of the present experiment was to extend these earlier findings by assessing the effects of textual disruption on both individual and dyadic-cooperative learning. An attempt was also made in the present experiment to use disruptions salient enough that all participants who encountered the disruptions would be affected to some degree. Further, in order to converge on the impact of the disruptions, measures of disruption recall, perceived difficulty of text segments, and over-all recall of text were administered.

Method

The present experiment was conducted in three sessions. In session one, one hundred and four undergraduates began by completing a series of individual difference measures. Following this, they were divided into two groups with an equal number of males and females in each group. In one of the two groups the participants were divided into same-sex dyads. Both groups then learned and practiced a four step learning strategy (Dansereau et al., 1979) either individually or dyadically according to their assigned condition. During the second session of the experiment the participants studied two different passages. They studied the first (initial) passage in the same condition that they were assigned in the previous session, while all groups studied the second (transfer) passage individually. For the initial passage, half of the dyads and half of the individuals studied a passage in which half of the four sections of the passage were purposely disrupted (e.g.

subject and verb switched, double negatives, gross misspellings etc). Thus, four groups were created by crossing dyad/individual with disrupted/nondisrupted group. In the transfer stage all persons studied a disrupted passage. During the final session of the experiment the participants were administered the three dependent measures described in the result section below.

Results

Two types of measures were employed in the present experiment. These were: a) measures which attempted to ascertain the degree to which individuals attended to disruptions and b) measures of over-all recall of the disrupted and non-disrupted sections of the text. The first measure of disruption attention consisted of a series of questions which asked the participant to indicate how many and which of the sections were disrupted (disruption recall). The second measure of disruption attention asked the participant to rate the relative difficulty of each section. A free recall test served as the measure of over-all recall (the test was broken down into disrupted and nondisrupted sectional recall). All three of these measures were administered for both the initial and transfer passages.

For the initial disruption recall tests the disrupted dyad group significantly outscored the disrupted individual group. For the transfer stage the non-disrupted dyad group significantly outscored the non-disrupted individual group. For the perceived difficulty differential test (disrupted

section difficulty - nondisrupted section difficulty) the disrupted dyads again significantly outscored the disrupted individuals in the initial stage, and both dyad groups combined significantly outscored the combined individual groups in the transfer stage.

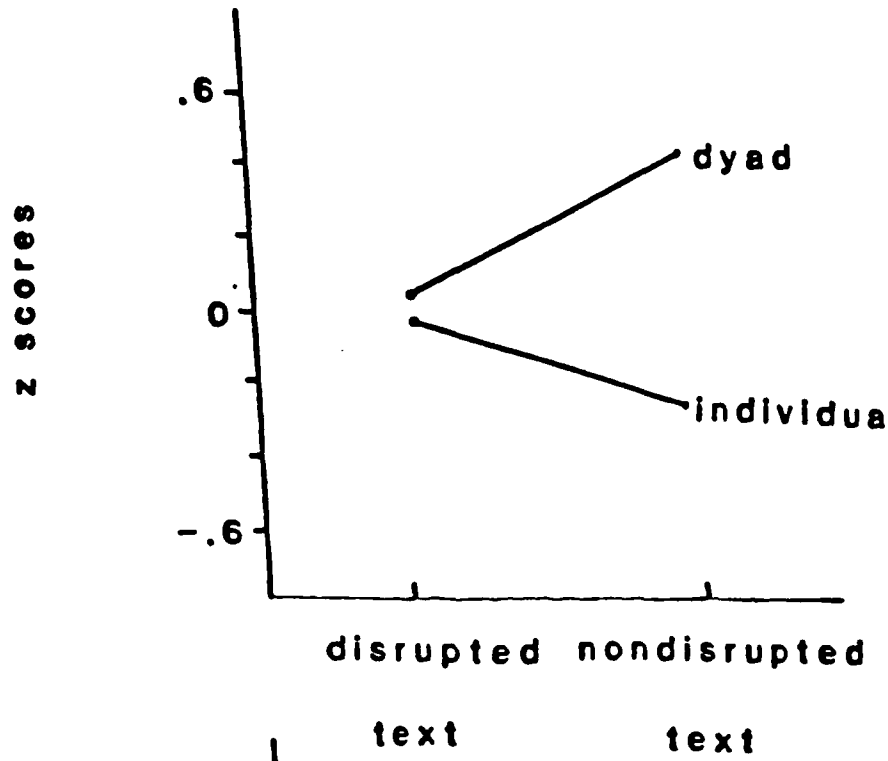
Both a significant main effect and three way interaction were found for the initial stage over-all recall scores. For the transfer recall two two-way interactions were found. In brief, these results indicated that dyads consistently outscored individuals on non-disrupted text, while there were not significant differences for disrupted text. (Figure 1 includes the relevant aspects of the over-all recall interactions.)

Discussion

The present results warrant two major conclusions. First, it appears that those who studied dyadically spent more time and/or effort processing the disrupted sentences (as indicated by their scores on the disruption recall and perceived difficulty measures). Not only do the results indicate that dyads attended more to the disruptions initially, but these participants also appeared to attend more to the disrupted sentences while studying alone in the transfer stage of the experiment. Second, although those who studied dyadically recalled significantly more in the non-disrupted text sections than individuals, they did not significantly out-perform the individuals on recall of the material contained within the disrupted sections.

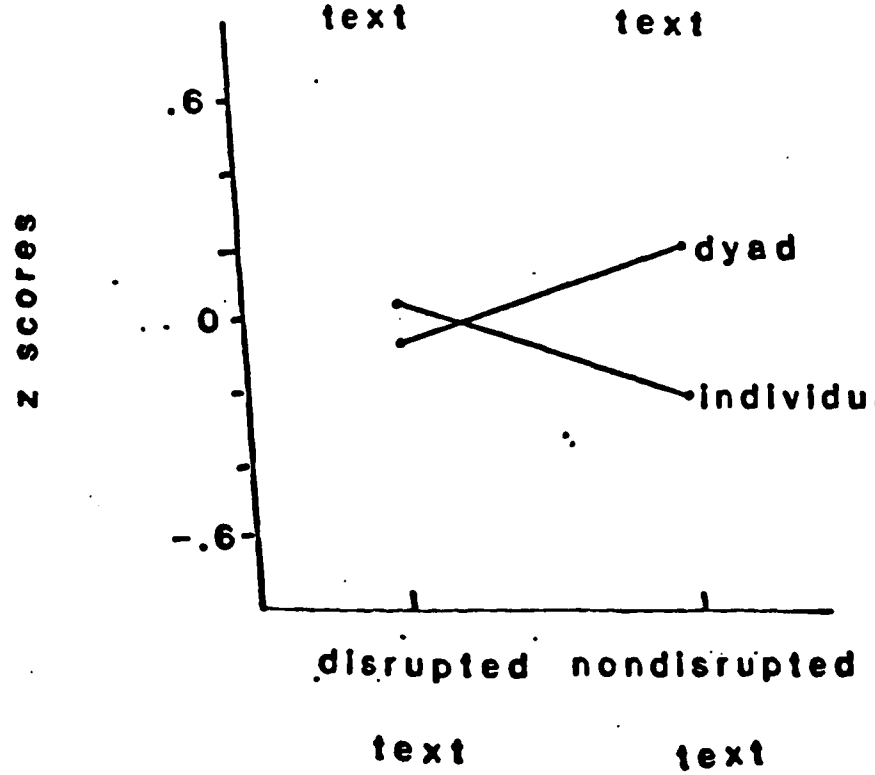
It is not surprising that those who studied in dyads

OVER-ALL RECALL



INITIAL STAGE

(disrupted groups only)



TRANSFER STAGE

(all groups)

would spend more time attending to the disruptions. Comprehension monitoring activities constitute one of the most salient aspects of cooperative learning (O'Donnell et al., 1985). Previous research has indicated that strategy manipulations which emphasize this aspect of cooperative learning can increase initial recall (Larson et al., 1985). The impact that dyadic learning had on recall of the disrupted sections is, however, somewhat counter intuitive. It appears that spending a lot of time and effort attempting to resolve disruptions, at least in the present context, can have a negative influence on processing surrounding material. Therefore, when the resolution of lexical problems within text is not necessary for over-all understanding, it appears that strategies (such as dyadic-cooperative learning) which encourage careful-detailed reading may actually discourage some aspects of effective learning.

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